

that plate 2 also is so dilated that it enters into this circle; and this increase indicates that when of a less size than 6·5 millims. *Mellita* may have all its ambulacra separate. This is actually the case in *Echinarachnius parma*. A young individual of this species, 6·5 millims. in length, has all five ambulacra similar; and their plates 2 are not yet broad enough to affect the form of the interrada, all of which are free and connected in uninterrupted sequence. But at a length of 34 millims. plates 2 of I. *a* and V. *b* in the bivium have so increased as to touch each other and interrupt the unpaired interradium, although one of the plates 2 is excluded from contact with plate 1 still only in interradia 1 and 4. It follows from this that the regular form, with five similar ambulacra and five similar interradia, is the primordial one in the Clypeastridæ, which is retained by *Echinocyamus* and *Laganum*, but from which *Encope*, *Clypeaster*, and *Stolonoclypus*, *Mellita* and *Rotula*, *Echinarachnius* and *Lobophora*, together with *Arachnoides*, depart during growth, the five last named, moreover, forming a bivium. Pressure towards the peristome during growth and the addition and great multiplication of new plates in the petala which are destined for the branchiæ have a great part in these changes. The "equator" is not the same during the whole life of the animal. We may see, by comparing several *Echinarachnii* of different ages, how a great part of the plate through which the periphery passes gradually goes over to the ventral surface, until the following one becomes visible there, and the periproctium, which is at first dorsal, becomes finally more than half ventral. At the same time the stoma of the test, as in the *Echini*, becomes less in proportion to the whole animal. In a *Mellita hexapora* 6 millims. broad the transverse diameter of the stoma is about 0·13 of that of the disk, at 8 millims. 0·1, at 35 millims. 0·04, and at 80 millims. 0·034.

[To be continued.]

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LIV.—*Contributions to the History of the Hydroida.*

By the Rev. THOMAS HINCKS, B.A., F.R.S.

I. *The Sarcothecæ (Nematophores) of the Plumulariidæ.*

[Plate XX. figs. 1-3.]

THE singular organs to which the name *nematophore* has been assigned by Busk, and which are confined to the Hydroid family of the Plumulariidæ, have been investigated by several able observers; and much light has been thrown on their structural and physiological history, though as yet little is known

of their precise function. Meneghini seems to have been the first to notice them; he was followed by Huxley (1849); and a few years later Busk gave a more complete and accurate account of them, and drew special attention to the important characters which they yield to the systematist. Allman (1864) studied the contents of the nematophore, and established the very interesting fact that the soft granular mass contained in it has the power of emitting extensile processes, very similar in structure and behaviour to the "pseudopodia" of an *Amœba*. More recently (1872) Kirchenpauer has minutely described the varieties of nematophore which occur in the different groups of Plumulariidae, and has applied the results of his research in a revised arrangement of the family\*. After all, however, one or two points have escaped observation which are worthy of record.

The presence of thread-cells in the protoplasm of the nematophore has been noticed by Busk and Allman. They seem not to occur universally; at least the latter observer failed to detect them in *Antennularia antennina*, Linn. In all the species which I have examined they are present, and occupy the same position.

It has been observed that these thread-cells are never carried out in the "pseudopodia"—a remark which indicates that the true structure of the protoplasmic offshoot enclosed in the chitinous case of the nematophore has not been determined. In all the cases that have come under my notice the terminal portion of the sarcode-mass was divided into two distinct and constant lobes, in one of which (the superior) the cluster of thread-cells was immersed, while from the other (the inferior) originated the extensile process.

In the nematophores which stand out on each side of the calycle in *Aglaophenia pluma* this bipartite structure may be studied to great advantage. The superior lobe (Pl. XX. fig. 1, *a*) is elongate in form, and extends from about the middle of the cavity to the outer extremity of the terminal aperture; it contains a number of rather large thread-cells, arranged longitudinally at the very summit. The inferior lobe, which originates at the base of the other, presents a rounded outline (Pl. XX. fig. 1, *b*) when at rest, and is composed of a simple granular substance.

In *Plumularia setacea* (Pl. XX. fig. 2) the bilobate character is equally marked, though, from the nature of the chitinous cup or bowl in which the nematophore terminates, the two lobes are more nearly on a level than in the previous species. At

\* 'Ueber die Hydroïdenfamilie Plumulariidae, einzelne Gruppen derselben und ihre Fruchthälter.' Hamburg, 1872.

the same time the portion containing the thread-cells stands out as a well-rounded prominence above the margin of the cup, while the extensile lobe originates at one side of it, a little below the summit. I have observed the same structure in *Plumularia pinnata*.

The division of the sarcode-mass towards its upper extremity into two processes with different functions is very apparent in the mesial nematophore, which adheres to the *front* of the calyche in *Aglaophenia pluma*. In this case the chitinous tube of the nematophore is not merely furnished with a terminal aperture, but also communicates with the cavity of the calyche to which it is attached. The lobe bearing the thread-cells extends to the top of the tube; the extensile (or inferior) lobe only to the point where this communication exists, and here it discharges itself into the calyche, as noticed by Allman, who does not seem, however, to have recognized the constant diversity of function in the two branches of the granular mass.

Kirchenpauer has described certain species of *Aglaophenia* in which the tube of the anterior nematophore has a second orifice, placed generally near the point at which it begins to stand off from the calyche; this orifice does not communicate with the cavity of the hydrotheca, but affords a passage for the extensile lobe into the surrounding water. He proposes to designate nematophores of this kind "double-mouthed" (*zweimündige*). This observer does not seem to have noticed the bilobate structure of the lateral nematophores, which I have just described.

We may distinguish, then, in the nematophore:—(1) the chitinous case, which may be simple (Pl. XX. fig. 1) or compound (fig. 2), and, if simple, furnished with one orifice only or with two; and (2) the soft granular offshoot from the ectoderm pervading it, which may be either entire and destitute of terminal thread-cells, or divided into two lobes above, one bearing thread-cells and the other extensile.

The protoplasmic processes which are emitted by the inferior lobe have been well described by Allman. They are very mutable, and exhibit frequent changes of form, often attaining a great length. Sometimes they are cylindrical and slender, stretching along the stems and branches, to which they are closely appressed and along which they glide slowly, almost imperceptibly, in *Amœba*-like fashion; sometimes they appear clavate at the extremity; sometimes they swell out at intervals into bulbous dilatations. Occasionally they may be seen to reach across to a neighbouring branch and fix the extremity upon that; and rarely they give off two branches at the top, which move in opposite directions (Pl. XX. fig. 3, *b*). I have

observed them in a state of great activity, as I have mentioned elsewhere, on a young specimen of *Plumularia frutescens*, which they completely invested with "a multitude of gossamer-like threads." These extraordinary prolongations of the granular mass in the nematophore can be entirely withdrawn.

The action of the thread-cells on the superior lobe is much more rarely witnessed; Meneghini seems to have noticed it, but without comprehending its true nature. On a specimen of *Aglaophenia pluma* I have seen the contents of the nematocysts discharged, and the long delicate threads streaming upwards from the extremity of the lateral nematophores (Pl. XX. fig. 1, *a*). These fine extensile lines were cast out to enormous distances, intertwining and waving about in the water; three or four were usually emitted from each cluster of thread-cells; and in some cases I noticed that the cyst itself was raised to some height above the nematophore and borne on a slender pedicle. At times a tuft of the threads might be seen slowly contracting, and I have observed one dragging down with it a mass of stuff which it had collected.

The sight of this wonderful apparatus in full action was singularly interesting, and it was impossible not to feel that it must bear some important relation to the life of the Hydroid. I may mention that the specimen on which the thread-cells were in action showed no trace of pseudopodia.

It is difficult to form a conjecture as to the function of these curious appendages. They have been regarded as organs of defence; and Kirchenpauer proposes to rank them with the polypites and gonozooids of the Hydroid colony under the name of the "defensive zooids" (*Wehrthiere*). But it seems to me very doubtful whether this is the true interpretation of the nematophore. I am inclined to think that its function may be in great measure nutritive; the pseudopodia at least seem much better fitted for the work of alimentation than for that of defence.

If we may accept Prof. Allman's very ingenious theory of the structure of the fossil Graptolites, we shall have important evidence in favour of this view. He regards them as morphologically Plumulariidans in which the development of hydrothecæ has been suppressed by the great development of the nematophores\*. In short, according to his interpretation, they were Plumulariidans in which the ordinary alimentary zooid (the polypite) was wanting, and the function of nutrition probably devolved altogether on the nematophores. If this view be correct we shall have, as Allman has remarked, in the

\* 'Monograph of the Gymnoblatic or Tubularian Hydroids,' part ii. p. 170.

nematophore of the existing *Plumularia* "the last traces of the structure of its ancient representative, the Graptolite."

In this case we must conceive of the remote ancestors of our recent forms as obtaining their food altogether after the manner of a Rhizopod, by help of the pseudopodia, which still survive to supplement the work of the polypite. This view, however, though ably supported, can hardly claim at present to be more than a happy conjecture.

A word as to the terms employed in this department of Hydroid morphology. With our present knowledge, *nematophore* can scarcely be accounted an appropriate designation for these singular appendages. The presence of thread-cells is certainly not the most significant or distinctive character which they exhibit; and it would seem that it is not universal. As we have already the terms *hydrothecæ* and *gonothecæ*, I should propose to name them *sarcothecæ*, while the offshoot from the ectoderm, which they enclose, may be appropriately called the *sarcostyle*.

## II. *New Species of Plumularia* (*P. cornu-copiæ*, *Hincks*).

[Plate XXI. figs. 1-3.]

I have lately obtained at Ilfracombe a new *Plumularia*, which exhibits some interesting points of structure. In the form of the calycle, the jointing of the stem and branches, and the general arrangement of the sarcothecæ (nematophores) it resembles *P. Catharina*, Johnston; but from this species it differs notably in size and habit, in the form of the gonothecæ, and in the alternate arrangement of the ramules. It is remarkable, however, that while the pinnæ are usually alternate and somewhat widely separated, one or two of the lowest pairs are not unfrequently opposite, as in *P. Catharina*. Another distinction between the two forms is to be found in the structure of the sarcothecæ that occur one on each side of the calycle; in *P. Catharina* they are pedunculate, in the present species sessile. Looking at the whole assemblage of differences and points of resemblance, it seems not improbable that we may have in *P. cornu-copiæ* a derivative from *P. Catharina*, though it is now a strongly marked and well-established form.

### Fam. Plumulariidæ.

#### Genus PLUMULARIA, Lamarck (in part.).

##### *P. cornu-copiæ*, n. sp.

*Plumes* distributed at intervals on the creeping stolon. *Stems* recurved, regularly jointed; a single internode between those which bear the ramules. *Pinnæ* generally alternate,



occasionally opposite towards the base of the plume, simple, moderately distant, a single calycle on the main stem at their origin. *Hydrothecæ* cup-shaped, deep, with an even margin, separated by two joints. *Sarcothecæ* bithalamic, one on each side of the calycle above and one below it, two on the intermediate internodes of the stem and one on those of the pinnae, and two on the longer internode near their base. *Gonothecæ* shortly pedunculate, springing singly or in pairs from the base of the calycles both on the stem and pinnae: female in the shape of an inverted horn, curved inwards towards the calycle; aperture suboval, oblique; two sarcothecæ near the base: male unknown.

Height of plumes about  $\frac{3}{4}$  inch.

*Hab.* On stones, dredged off the Capstone at Ilfracombe.

The plumes of *P. cornu-copice* are compact and slightly recurved. The pinnae are not very distant, and of moderate length, seldom bearing more than six calycles; I have never seen them branched. The internodes which separate the hydrothecæ are not nearly so long as in *P. Catharina*, and bear only one sarcotheca, whereas there are two or three in the latter species. The much greater length of the internodes, both on the stem and branches, in *P. Catharina* confers on this species a very distinctive habit. It approaches *P. cornu-copice* in many of the details of its structure, but not at all in general appearance. The pinnae of the latter species are decidedly alternate, with the exception I have mentioned above. The most striking feature undoubtedly is to be found in the gonothecæ, the peculiar form of which has suggested the specific name\*. They originate, as in *P. Catharina*, at the base of the calycles, sometimes singly, but frequently in pairs, and are perfectly hyaline and of the most delicate texture; they are of ample size and most gracefully curved, bearing, like the similar parts in the allied species, two of the bithalamic sarcothecæ near the base. The polypites are adorned, just below the tentacles, with a conspicuous belt of opaque white, which forms a striking feature.

### III. *Reproduction by Fission in Campanularia neglecta*, *Alder.*

[Plate XX. fig. 4.]

Allman has described a case of reproduction by spontaneous fission in a Campanularian Hydroid which he has referred to a new genus under the name of *Schizocladium*†. I have had

\* The gonotheca is like an exquisite little crystal cornucopia.

† Report of the British Association for the Advancement of Science, 1870; 'Monograph of the Gymnoblasic Hydroids,' part i. p. 151.

the opportunity of observing the same mode of development in *Campanularia neglecta*, Alder, and have little doubt that it is far from uncommon amongst the Hydroida. In the month of June I obtained a fine colony of the *Campanularia* bearing a full complement of polypites and also a considerable number of branches, carrying at their extremities the planuloid extensions of the coenosarc described by Allman (Pl. XX. fig. 4, x). I am inclined to think that they were of greater length than those of *Schizocladium*, but in other respects exactly resembled them. I did not actually witness the liberation of the frustule, but in one case at least a constriction was very apparent a little within the chitinous tube of the stem, at which point no doubt separation would ultimately have taken place.

I confess that, with great deference for Prof. Allman's opinion, I am unable to accept his genus *Schizocladium*, which seems to rest on a single character, the development of fission-frustules in a certain way—a character which, there is reason to believe, may have a wide range amongst the Hydroida. There seems to be nothing peculiar in the trophosome of his zoophyte but the presence of the frustule-bearing branchlets; there is nothing in his account or figure of it, apart from this character, to indicate that it is even specifically distinct from known forms of *Obelia* or *Campanularia*.

The observation of reproduction by fission in *Camp. neglecta*, and its probable occurrence, as recorded by Allman himself, in *Corymorpha*, tend to show that *schizocladism* may be a common element in the reproductive history of the Hydroida, and that it therefore cannot be the peculiarity of a genus. The frustule with its branchlet is hardly likely to exhibit any morphological peculiarities that will serve the purpose of the classifier. It presents the same character in *Camp. neglecta* as in Allman's Hydroid, which is probably an *Obelia*.

Prof. Allman has made a most important and interesting addition to our knowledge of the modes of reproduction amongst the Hydroida; but I venture to think that he himself will hardly care to retain the new genus.

#### IV. *Cladonema radiatum*, Dujardin: the Planoblast.

[Plate XXI. fig. 6.]

Through the kindness of Dr. Hudson, of Clifton, I have had the opportunity of examining during the past summer, for the first time, the planoblast of *Cladonema radiatum*, which he had taken at Watermouth near Ilfracombe. I was surprised to find the tentacles unbranched and furnished with only one suctorial appendage. In this state they bear a very close resemblance to those of *Clavatella*, the only important difference

between the two being that in *Cladonema* the thread-cells are distributed in several clusters (about five) along the arm, while in *Clavatella* they are gathered into a single spherule at the extremity. Van Beneden has observed that in an early stage the tentacle of the planoblast is destitute of branches, and is furnished with two suckers: it appears that in a yet earlier stage it has only one. Allman, in the concluding part of his great work on the Tubularian Hydroids, has made the same observation, and he adds that "in a very early stage" (before the liberation of the gonozoid) "the marginal tentacles are quite simple." At the time of detachment one suctorial appendage has been developed; and, according to the observation of Van Beneden, a second makes its appearance before the branching of the tentacle commences\*.

Judging from Allman's exquisite figure, the bifurcation of the tentacles begins at a later period in *Cladonema* than it does in *Clavatella*; in the latter the minute lobes on the margin of the disk, in which they originate, exhibit almost immediately a slight depression in the centre, indicating the future course of development.

I was much interested in watching the curious habits of the young *Cladonema*. It was exceptionally hardy, and throve well in confinement. But after a short time it proceeded to reverse its swimming-bell (just as a man might throw off his coat on commencing a piece of hard labour), and, firmly planting itself on its suctorial appendages, made a vigorous attack on the minute crustaceans that swarmed in the surrounding water. The manubrium, unimpeded by the restraint of the umbrella, and placed on a decided vantage ground, moved eagerly from side to side, and with the aid of its well-armed oral lobes succeeded, I have no doubt, in securing abundant supplies. The zooid in this condition presented an extraordinary figure: the characteristic grace, with much of the familiar appearance, of the Medusa had vanished; and the stout cylindrical proboscis, mounted on a kind of pedestal and swaying to and fro as the little Entomostraca played about it, offered a strange contrast to the exquisite form of which Van Beneden could say, "rien n'est gracieux comme un Cladonème."

The retroversion of the umbrella has been noticed in several species and by several observers—but always as occurring late in the life of the zooid, and shortly before the escape of the generative products. When the walls of the manubrium were already laden with ova, I have seen the swimming-bell in the planoblast of *Syncoryne eximia* thrown back and contracted into a small mass, to which the tentacles were still attached.

\* 'La Faune Littorale de Belgique: Polypes,' 1866, p. 142.



The locomotive organ perished, and the zooid in its last stage returned to the condition of the polypite. But in the case of the young *Cladonema* the umbrella, though everted, continued otherwise unchanged, and manifested its healthy condition by vigorous contractile movements; it was clear that at any moment it might be restored to its normal position, and discharge its functions as efficiently as ever.

This peculiarity of habit in the planoblast of the *Cladonema* no doubt connects itself with the presence of organs of attachment, which amongst the natatory gonozooids it alone possesses.

I may mention that I was unable to detect any thread-cells on the umbrella, nor is there any reference to their existence in Allman's description; but they are represented in Mr. Holdsworth's excellent figure engraved in my 'History of the British Hydroida'\*.

#### V. *Zanclaea* (*Gemmaria*) *implexa*, Alder.

I have to record the occurrence of this very beautiful Hydroid at Ilfracombe, where it was found on the Capstone, and dredged up from a moderate depth not very far from shore. In the former locality it grew on *Laminaria*-roots in the lower rock-pools. All the specimens obtained were spreading over masses of *Cellepora*, in the orifices of which the polypites were lodged; Mr. Hodge obtained it in the very same habitat at Seaham Harbour. Hitherto this species has only been met with on the coasts of Northumberland and Scotland.

The form found in Devonshire is the one first described by Alder as *Coryne pelagica*, which he subsequently considered to be the young of his *Tubularia* (*Coryne*) *implexa*—and is identical with the *Coryne briareus* of Allman, and the *C. margarica* (natural-size figure) of Wright. It is also the one so beautifully figured in Allman's 'Monograph' as *Gemmaria implexa*, the polypites of which are borne on short and simple stems about half a line in height. At first sight this form seems very unlike the Hydroid with branching tubes, growing gregariously and forming "a densely tangled mass" from a half to three quarters of an inch in height, which Alder has described as his *Coryne implexa*. I have little doubt, however, that the two must be referred to the same species.

I have fine specimens of *Zanclaea implexa* from the Firth of Forth, kindly supplied by Dr. Strethill Wright, in which the two forms are associated. The creeping stolon gives off many short stems enclosed in a polypary, which tapers slightly downwards and is annulated throughout the greater part of its length, the upper portion, however, being smooth and of more delicate

\* 'History of the British Hydroid Zoophytes,' vol. ii. pl. 11. fig. c'.  
Ann. & Mag. N. Hist. Ser. 4. Vol. x. 28

material than the rest. These are unbranched, and bear at their summit a single polypite. Associated with them are much longer stems, branched for the most part unilaterally, and invested by a polypary exhibiting the curious structure described by Alder. Polypites are borne on the summit of the main stem and of the several ramules. The polypary is composed of two layers or coats, distinctly separated from one another—the outer transparent and membranous, the inner of a decided horn-colour and for the most part strongly ringed\*.

Every here and there portions occur in which the separation of the two coats is not apparent; but throughout the greater part of the stems and branches it is strongly marked.

The inner tube is completely filled by the cœnosarc; its carinated rings are connected with the epidermis by frequent processes. Towards the base of the stems this singular structure is not generally distinguishable; but the "thin and transparent" polypary, which Allman describes as occurring in his specimens for some distance below the polypite, is no doubt the epidermal layer, forming in other parts of the stem a continuous distinct envelope, and enclosing the annulated tube which immediately surrounds the cœnosarc. It appears that the form with short and simple stems, associated in the Firth-of-Forth specimens with the larger branched form, not uncommonly occurs alone; and as in this condition it bears the reproductive bodies freely, it cannot be accounted immature.

That the *Tubularia implexa*, Alder, and the Firth-of-Forth species are identical is beyond a question †; and Dr. Wright's specimens show that the humbler form described by Alder (as *Coryne pelagica*) and by Allman, and found by myself at Ilfracombe, is only one state of the same species. A complete diagnosis of *Zanclæa implexa*, therefore, must include the branched double-coated stem, which belongs to the perfect condition of the zoophyte.

The polypites have five or six large-headed tentacles round the oral extremity; the rest have very small capitula, containing a few thread-cells. I have noticed a large oval thread-cell at the base of most of the tentacles and imbedded in the ectoderm at various points, where tentacles would probably have been developed. Occasionally one occurred in the course of an arm, and a group on the surface of the body.

The gonophores are borne in large clusters, and number

\* Vide 'History of the British Hydroid Zoophytes,' pl. 9. fig. 3 b.

† I have compared specimens of the polypary of the former, received from Mr. Alder, with the latter; and they exactly agree, as already observed by Wright.

sometimes as many as seven. The sacs containing thread-cells on the umbrella of the planoblast were placed, in the Ifracombe specimens, a little way above the tentacular bulbs; they are represented in the same position in Alder's figure; but Allman describes them as extending upwards for some distance from the base of each tentacle.

I have referred the *Coryne implexa* of Alder to Gegenbaur's genus *Zanclæa*, and at present I see no reason to change this view. M'Crady, indeed, has instituted the genus *Gemmaria* for a planoblast which seems to agree in all essential (generic) points with that of our British form; the trophosome he had not discovered. But I can find no sufficient ground for this addition to an already oppressive nomenclature; *Zanclæa* and *Gemmaria* seem to me to embrace one and the same generic type. The main characteristics of Gegenbaur's genus are a bell-shaped umbrella, a moderately long manubrium with simple mouth, four radiating canals, tentacles springing from non-ocellated bulbs and furnished along their course with pedunculated sacs containing thread-cells, and certain prominent "ribs" on the umbrella, in which thread-cells are enclosed; and these are really the essential characters of *Gemmaria*. Allman, however, has adopted M'Crady's genus, but has not given us his reasons for doing so. It is of course possible that the structure of the pedunculated sacs on the arms of *Zanclæa costata* (Gegenbaur) may differ essentially from that of the similar organs on *Coryne implexa*, Alder; but it is hardly probable. It is also possible that the "ribs" on the umbrella of the former may not correspond with the "sacs" on that of the latter, though it seems likely enough that the same kind of structure is intended in both cases. But with our present information, and looking to the whole group of characters, it seems to me better to hold provisionally at least to Gegenbaur's name.

Alexander Agassiz also accepts M'Crady's genus *Gemmaria*, and has given us his reasons; "the form of the bell," he says, "of the digestive cavity, and of the tentacles is totally different in the two genera." "The form of the bell" is a very doubtful generic character; but the differences in this respect between the supposed species of *Gemmaria* are quite as great as those between any one of them and the *Zanclæa costata*. The form of the digestive cavity is a matter of inferior moment; there are no important differences in size or structure. The tentacles may not agree in shape, though there is little disagreement in this respect between *Zanclæa costata* and *Zanclæa implexa*; but they seem to be similar in all essential points.

On the whole I see no reason for dispossessing the established name.